Knowledge management and innovative design: state of the art

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KNOWLEDGE MANAGEMENT AND INNOVATIVE DESIGN:

STATE OF THE ART

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Abstract:

The objective of this article is to make a state of the art on knowledge management and its bond with the innovating designs. After having presented some general information on knowledge, its typology and its cycle of management, we will move on its patrimonial management, then we will finish on the knowledge management for the innovative design.

Keywords:

Knowledge management, design, innovation

1. INTRODUCTION

Into a company, the management of knowledge can be apprehended in two manners: 1) The defensive manner builds the stock of knowledge to face the departures of personnel. 2) The more offensive manner sees in the knowledge development an advisability to generate new products as well as new and more competitive manufacturing processes. Moreover, the design is a process which provides a product or a service. All the designs are not innovating. It is probable that a repeated absence of innovation is more or less quickly prejudicial for a company. [19] confirms the positive correlation between the results of the companies and their investment in the knowledge management. The techniques of information and communication support these tendencies by allowing the fall of the cost of formalization and transmission of knowledge [26].

2. KNOWLEDGE'S TYPOLOGY AND CYCLE OF KNOWLEDGE MANAGEMENT

Knowledge is more and more specialized [21]. Because of this division of knowledge, its synthesis and thus its operational character are increasingly delicate to build. A typology can contribute to their management [2]. [30] introduced tacit knowledge through its formula become famous: “We know more than we cannot say”. [29] developed these concepts of explicit and tacit knowledge by connecting them at the same time to their collective and individual dimension. Tacit knowledge is expressed for example by dexterity (tacit technical) but also through the knowledge that is hidden within the people (tacit cognitive). Tacit

knowledge is then difficult to formalize and communicate [20] but a part of them can be explicated. Explicit knowledge is written. In a firm, the knowledge would be expressed for 30% in an explicit form and 70% in a tacit form [10]. Otherwise, learning is embedded in the organizations [14]. In other words, an organization knows more than the sum of the knowledge used by each of its members. In particular, this capital is made up of the instructions, of the routines [2], of the patents, the machines and the data-processing programs but also of the interactions between individuals. Otherwise, these interactions build new knowledge specific to the organization. The collective dimension of the individual knowledge suggested by [20] is opposed to its private dimension. However, this approach should not make forget that collective knowledge has a life of its own independent of individuals. Ultimately, only the individuals make live this collective knowledge but those can outlive their departure. [20] also enriches typology by a temporal dimension: stable knowledge for some duration (static knowledge) and unstable knowledge (dynamic knowledge).

Knowledge is capitalized through a knowing base. It grows rich by new knowledge acquisition. This new knowledge needs knowledge to be produced. This duality of knowledge introduces its cyclic character [29]-[20]-[16]. The variation of tacit and explicit knowledge in an organization results in identifying four natures of knowledge transformation [29]. According to scenarios, these four types of transformation touch the individuals, the groups and the organization. Regarding the ways to be deployed for each of the four modes of transformation of knowledge, [28] announced the importance of a sharing platform: the Ba[1]. This space is physical like an office or virtual like a forum associated with a community of practice. The Figure 1 Spiral of knowledge conversion or model SECI [29] shows these four modes of transformation by linking them to the actors structures successively concerned i.e. the individuals, the groups and the organization itself. They are described below:

- From explicit to explicit by the combination; the groups rebuild knowledge.

- From explicit to tacit by the internalization; the individual integrates know-how from being with the other individuals and groups of the organization.

- From tacit to tacit by socialization; the interaction between individuals causes this transfer of tacit knowledge.

- From tacit to explicit by externalization; the groups makes explicit a part of tacit knowledge of the individuals.

Of course, knowledge management needs human and organisational approaches [27]. But without technology of knowledge management, the practice of sharing is restricted to the neighbour groups. In this case, the management is limited in time and space [7]. Thus, it is important to manage knowledge in a technological logic even if this management is not only that.

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[1]  "Ba is an ideogram of which the left part is comparable to the ground, with boiling water or with what raises and whose right part means what makes possible " according to [18]

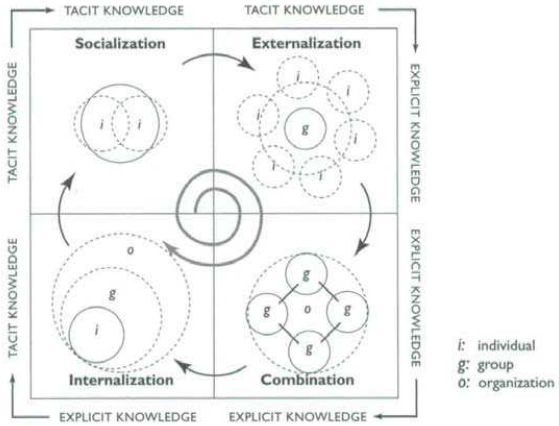

Figure 1: Spiral of knowledge conversion or model SECI [29]

3. PATRIMONIAL KNOWLEDGE MANAGEMENT

This patrimonial management functions according to two successive stages. The first stage draws a map of the firm's knowledge. It establishes their criticality i.e. their importance for the company because of their scarcity, of their complexity and the difficulty of building them. The second stage aims to produce an action plan to reduce this criticality.

3.1. Knowledge mapping

[6] makes three types of approach of the cognitive resources cartography by the description of knowledge, competences and the associated processes (See Figure 2).

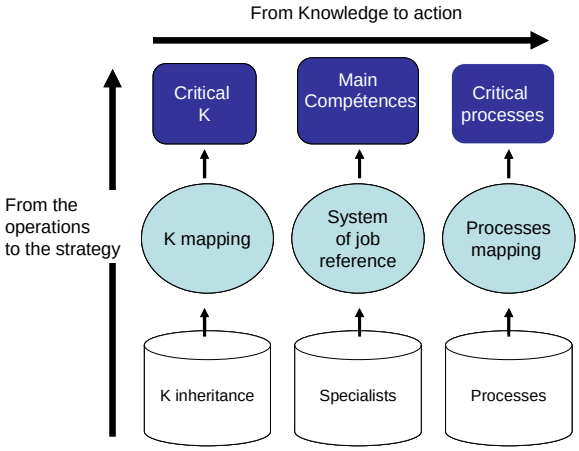

Figure 2: The three approaches: Knowledge/competences/processes [6]

• Conceptual approach or by field (K inheritance): A field is related to a type of a group of actors activity. This approach is adapted to levels of high complexity. It is illustrated for example by trees or cognitive maps [17].

• Functional approach (Specialists) marks competences. It is fast to implement. The hierarchy privileges it. Similar to an organization chart, it is thus very dependent of the organization.

• Procedural approach (Processes) is the only one of the three methods connecting the knowledge to the work. This approach is rather complex to implement.

These three cartographic modes are connected according to the double logic that is presented in the Figure 2 above. On one hand, a first logic which goes from knowledge to action, and on the other hand, a second logic which circulates from an operational level to a strategic level. In each one of these cartographic modes, the level of criticality can be displayed.

3.2. Action plan to reduce the critical knowledge

The cartography of knowledge brings out its criticality. To reduce it, it involves the development of this knowledge and its holding by a significant number of actors. But the knowledge inheritance is bicephalous. At the same time, it accumulates explicit and tacit knowledge. The two great types of transfer and development of knowledge are direct and indirect [17]. They are materialized in Figure 3 Knowledge transfer.

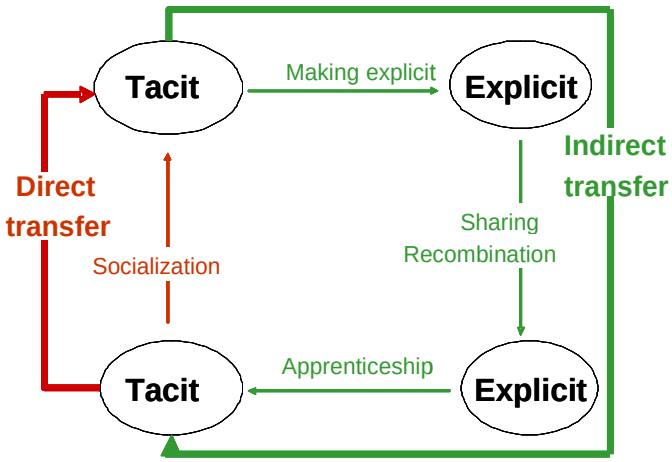

Figure 3: Knowledge transfer [17]

These two modes of management are well distinguished. Either the organization manages the people and their tacit knowledge, or it manages explicit knowledge [17]. They are often complementary within the same firm. The data-processing techniques and Internet produced new approaches of the knowledge management [31]. Most of the methods and tools that are described infra exploit these techniques. They handle especially explicit knowledge but they may also manage the interactions between individuals.

3.2.1. Indirect transfer

Making explicit knowledge leads to more or less structured textual documents but also to models [15]. Sometimes, It could be expensive to implement this [17]. For that, it is necessary to go to the essential points [26] and to stand up to the temptation of writing

everything. Two types of knowledge creation are distinguished: Those having for support the project control and those resulting from people having competences (method MASK[2], CommunKADS method[3], approach by the experience feedbacks like Rex[4], Merex, management tools of contents…).

There are many tools which share the company memory [13]: good practices guide, knowledge server, cognitive maps, ontology, hypermedia system, expert system and cased based reasoning system. The two last tools answer to well defined and structured repetitive problems in an automatic way [8]. They integrate explicit knowledge that they even share by their diffusion. Unfortunately, they are not adapted to undecided, progressive or rare problems. Moreover, the expert systems or the cased based reasoning systems require important investments including in maintenance. For its part, the semantic Web exploits the resources of stored knowledge in an innovative way. Whereas, taking into account the multiplicity of the sources, the traditional standard search engines like Google provide lists of documents increasingly rich; the semantic Web has for ambition to go further using the resources of the Web in a targeted way. However, the semantic Web mainly remains to be built.

3.2.2. Direct transfer

Tacit knowledge is carried by the cognitive processes of the individuals. Thus, the directories of experts count the individuals carrying know-how without seeking to clarify the latter. This mode of management makes cooperative work easier. More exactly, around a shared learning, a network, i.e. a knowledge community, connects these individuals. The animation of tacit knowledge passes by the identification and management [32] of these communities of practice, their process of sharing as well as their uses of the technological tools. This cooperative process was historically in a unit of time and place. However, the development of collaborative tools [7] collecting in particular voice, text and images widens this “original Ba” [12] allowing exchanges in environments that are differentiated in time and in space [20].

3.2.3. Networks

A network is not reduced to exchanges of tacit information. The principal purpose of a community of practises is to capitalize the good ones. Its bases are the presence of an active and recognized organizer [24]-[10] the undertaking of each one, a confidence built in particular by the organizer and shared, the common representations of knowledge, the collective practice of tools, the bonds with the activities of the organization [24]. This type of network is not only virtual one. It uses regular meetings. The step of capitalization requires a method: to build accounts, to decontextualize and to compare them, and to get some invariants [26]. The members of the network have to stand back from their own work. An operation or a reasoning becomes an invariant if they are met systematically in different situations. These invariants are capitalized. In new environments, the invariants are contextualized to be applicable. In a given context, there is thus a scope for initiative and for creativity for each actor to build an innovating practice starting from the constants constituted by the invariants.

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[2] MASK : Method for Analysing and Structuring Knowledge

[3] CommonKADS began again and extended method KADS: Knowledge Acquisition and Structuring Design

[4] Rex, Merex: Methods of experience feedback

4. KNOWLEDGE MANAGEMENT AND INNOVATING DESIGN

The innovator perceives a social need and designs an object which answers to it, starting from an appropriate technique [22]. The inventor imagines original and operational solutions. If the inventions enrich the possibilities of innovation, they are called “innovating invention”. The history of creation shows that it does not obey the logic of the white page. An innovation like an invention falls under the assumption of the “dependence of the path” [9], i.e. it emerges from the environment in which it was built. The innovation is a process of endogenous and cumulative creation [11]. An invention follows its course in a network of constraints. The creativity generally emerges from a good coordination between internal know-how of an organization and the external knowledge that is accessible by monitoring technological development [9]. [26] proposes that the knowledge is shared as much as it accumulates. New ideas emerge thus of the crossing of various disciplines and by analogy. It will be noted that according to the SECI model of Nonaka, this mixing is carried out by the individuals who interfere in the external world (see figure 1). For its part, the daisy's model proposed by [17] gives to the organization a more voluntary role in the search for information by the practice of technology watch.

Many ideal models of creativity exist. They are based on two essential phases [3]. The first phase, entitled divergence, explores original solutions. The second phase, known as convergence, evaluates and adopts an innovating solution acceptable. However, the invention is still often the production of the test-error type. Many authors theorized on the genesis of new knowledge through methods.

- Triz [4] gathers a set of more or less independent tools adapted to the problems resolution [23]. Engineering and design departments adapted Triz to solve problems [5]. But unfortunately, Triz lacks of a theoretical base [23]. The scientists thus adhered little to this method.

- Value engineering aims to reach the best ratio quality/price compared to the expectations of the customer. Value engineering proved that it is reliable. It is widely diffused in the firms but also in the services. The standardized definition of the method [1] is as follows: “Method of competitiveness, organized and creative, aiming at the satisfaction of the need for the user by a specific step of at the same time functional and multi-field design ". This definition insists on the multidisciplinary and creative character of value engineering. It also has an organized and economic dimension. It thinks about a product or a service as a set of functions. The functions are identified, evaluated and treated on a hierarchical basis according to customer's requirements. The creativity of the method applies as much to the search of new functionalities as to innovating solutions of production [3]. It is centred on the design.

- [24] propose to reorientate the knowledge management by integrating it into the logic of company designs. The unstable state of the contemporary industrial world, the permanent questioning of knowledge and working procedures of the company implies a paradigm change. A knowledge management does not cross only the project management and the animation of community of practices. It would be more dynamic accompanying even the product design [24]. Theory C-K developed by [25] formalize this unified theory of the design. It results from the method of "Branch and bound". To be able to innovate, it is necessary to exceed the framework of knowledge, because an expansion logic is in work. A design then needs a space of the concepts distinct from knowledge space to formalize new ideas. Theory C-K thus uses two spaces: The knowledge space K, K being a proposal having a logical status and C, C being a proposal with a non-logical status. The dynamics of exchange between these two spaces will mark the design process. One of the interests of theory C-K is to trace the reasoning associated with the design.

5. ASSESSMENT AND PROSPECTS

The state of the art made emerge interesting solutions to manage knowledge in the industrial world. Our work aims to apply these knowledge management strategies to agriculture. Indeed, the agricultural world poses a certain number of specific difficulties. Thus, if the knowledge management implies that the networks of knowing and the networks of power cohabit; their identification is not self-evident in the agricultural world. Indeed, research, the agricultural consultancy and the farmers do not have obliged nor contractual relations as within the framework of the company with its development and research laboratories, and its subcontractors, for instance. Moreover, knowledge is primarily tacit in the farms. In these family companies, the transmission of knowledge takes place more between father and son, or between peers for example at the fields meetings, than through explicit documents. The question of the capitalization of the knowledge accumulated by the farmers is thus complex to implement. Then in agriculture, the cycle of Nonaka applies in an incomplete way. If the direct transfer of knowledge is effective, their indirect transfer by the clarification of tacit knowledge, their sharing and their apprenticeship is not easily operational. The recombination of explicit knowledge, that they result from the practices of the farmers or produced by the agricultural consultancy or agricultural research, in fact is difficult. The innovation for a sustainable agriculture is thus penalized by it. It is thus necessary to imagine a tool of capitalization and recombination of knowledge.

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